Potential digital optimisation of the poultry enterprises in Nigeria: a factor analysis of farm-level characteristics

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Abstract

Digital technologies portend innovative optimisation of mundane and economic activities. The study assessed poultry farmers' disposition towards relevance of the digital systems for optimizing poultry farming, examined the associated constraints, and identified the underpinning factors. Simple random sampling was employed to select one hundred thirty-seven farmers from the registered group in Osogbo, Nigeria. The validated questionnaires were analysed using descriptive statistics and principal component (factor) analysis. The results showed that farmers prominently agreed that drone deployment in poultry farming reduces high running costs (WMS=3.63 ±0.86). Only 9.3% deployed ICTs for poultry management, while a fully digitalised system was nearly nonexistent (0.7%). The most severe constraints besetting poultry farming digitalisation are poor production scale (WMS=3.78 ±1.4) and fear of cost-ineffectiveness of digitalisation (WMS=2.78 ±1.4). Isolated factors underpinning the potential digitalisation of poultry enterprises are 'poultry farm operational capacity', 'digitalisation familiarity and experience', and 'social contact and management dispositions'. These factors jointly accounted for a 78.3% variation in the digitalisation potential of poultry enterprises. In conclusion, advancing digital optimisation of poultry enterprises in Nigeria depends on the potential to improve farmers' socio-economic resilience and external orientation. Therefore, adaptive research should be prioritized to develop socio-economic class-appropriate digital tools for poultry management.
Keywords: agricultural enterprise, digital technologies, Information and Communication Technology (ICT), poultry digitalisation, poultry management.

INTRODUCTION

Innovations in agriculture are required to enhance agricultural systems, enabling them to meet the growing demands for sustainably higher productivity and greater contribution to t to contribute more significantly to people's well-being and the nation's economic growth. Digital technologies are the latest innovation for technologically upgrading and optimising mundane and financial activities. The increasing utilization of digital technologies for managing, leading and transforming people`s live and work has led to a great differentiation (Fichman *et al.,* 2014). The imperatives are out of the global value reorientation for smarter, more efficient and effective services and products with great distinction (Economic Commission for Latin America and the Caribbean (ECLAC), 2021). This is equally strategic to the quest of third world countries towards attaining the sustainable development goal 9- industry, innovation and infrastructure. This highlights that it is becoming progressively necessary to key into the trend of production digitalisation to ascertain the maintenance of market competitiveness and systemic flexibility (Gorenšek & Kohont, 2018; Santos-Pereira *et al.,* 2022). Therefore, production systems relevance is gradually becoming a function of

digital technology inclusion as evinced by global trends and sustainable development targets. The potential of the transformation to be opportune is innumerable as it would result in major organizational changes and redefinition of the market dynamics (ECLAC, 2021).

African agricultural system is very relevant in tapping the potential of digitalisation. These will deliver socio-economic benefits to the largest proportion of the masses and help to secure the nation's relevance in international agro-economic trades. In recognition, several African countries are improving their digital facilities for agricultural transformation through digitalisation. Notably, Côte d'Ivoire and Ghana have delivered greater digital presence in the rural areas (Degila *et al*., 2023). In Ghana, the Esoko e-advisory and inputs facilitation system targeted at smallholder farmers is a success story which has birthed more improved and specialised digital support for agricultural development (The Alliance for a Green Revolution in Africa, AGRA).

Nigeria is part of the wave of digital technologies' penetration and agricultural initiatives (FAO and ITU. 2022). Significantly, the country is one of the few in Africa that has strategically drafted the policy roadmap for agricultural digitalization (Degila *et al.,* 2023). There is also remarkable improvement in the level of awareness of digital technologies for agriculture alongside the existence of digital support services to farmers such as ThriveAgric, EZ Farming, and Farmcrowdy (Oruma *et al*., 2021, Akinwale *et al.*, 2023). These portend viable mechanisms for promoting and consequent inclusion of digital tools in agricultural production processes. The peculiarity of the poultry industry as a leading agricultural sub-sector by its relative organization and importance (Netherlands Enterprise Agency, 2020), highlight its strong potential for significant upgrade through digitalisation. It is necessary to close the vicious gap of underperformance of the sector despite

its huge potential. In Nigeria, the poultry industry contributes as much as 25% to the agricultural GDP from average annual production of about 300 Mt of poultry meat and 650 Mt of table eggs, while employing about an 85 million Nigerians (LiveGAPS factsheet, 2020). However, the industry is incredibly far from meeting the local demands despite having the potential and resource base (Heise *et al.,* 2015; LiveGAPS factsheet, 2020). Infrastructural and technological lag are among the major pinpointed factors. Shang *et al.* (2021) opined that digital farming enables the transformation of such existing agricultural systems towards sustainability.

Groher *et al.* (2020) highlighted the increasing access, capacity and availability of usable digital tools for livestock production like poultry farming. Thus, the opportunity to employ digital technologies such as sensors, simplified robots, 3D printers, and artificial intelligence portends immense importance if deployed by farmers for appropriate poultry activities. However, understanding the barrage of factors stemming from the popularity of digital technologies to farmer agency characteristics and digital innovation features concerning the poultry enterprise in Nigeria's context has not received considerable attention in the literature. Therefore, ascertaining how poultry enterprises fared in disposition towards deployment of digital technologies and identifying the critical factors underpinning digitalisation from farm-level operational features and poultry management is the impetus for this study. The Food and Agriculture Organization (FAO) (2022) emphasized the need for such empirical assessment of utilization of digital technologies in agricultural systems of developing economies like Nigeria. In comparison to the previous studies on the Nigerian context done by Oruma *et al.* (2021), Umar *et al.* (2022), and Akinwale *et al.* (2023) who highlighted the potential and panaceas for digitalization in Nigeria agriculture, current study will go further in attempt to uncover

specific factors that could drive digitalization in the subsector. The specific objectives of the study are to: (1) assess farmers' disposition towards the relevance of digital technologies for optimising poultry activities; (2) examine the perceived constraints to the deployment of digital technologies in poultry enterprises; and (3) identify the critical factors underpinning poultry enterprise digitalisation in the study area.

MATERIALS AND METHODS

The study targeted members of the Osun State Poultry Farmers Association of Nigeria (PFAN). A random sampling technique was used to select respondents from the attendees of the association's meetings. This yielded a total of 137 poultry farmers from a population of 200. Data collection was done using validated and structured questionnaires. Data was collected on the poultry farmer's enterprise characteristics, their knowledge and perception of the relevance of digitalisation, constraints to the digitalisation of poultry enterprise, and technicality of the poultry operations among others.

Farmers' perception of relevance was measured with a Likert scale including 'strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree' with corresponding scores of 5, 4, 3, 2 and 1, respectively. For description, strongly agreed and agreed were summarized as positive affirmations by the farmers, while strongly disagree and disagreed denote negative or unfavourable dispositions. The midpoint, undecided is described as dispositional indifference to the viewpoint presented with the perceptional statements. Measurement of the severity level of the constraints was operationalized with a rating scale of 1 to 5, wherein 1 corresponds to the least severe while 5 designates the highest severity. The technicality of poultry farming operations to assess the level of automation of the poultry industry was measured through a rating scale ranging from 1 to 4 and corresponding to

manual operation up to automated or digitalised operation. Data was analysed with descriptive tools including frequency counts and percentages, weighted means and standard deviations. More so, principal component analysis was conducted to identify poultry digitalisation factors. Factorial ANOVA was employed to test the significance of categorical enterprise variables on poultry digitalisation.

Analytical approach

This is correlational research involving variables measured to explain poultry enterprise features. Their indication as a pointer to the farm operations and management portends information on farmers' experience and outlook about technological deployment in the system. Identifying possible groups of variables underlining digital technologies' use from the array of farm-level characteristics described necessitates dimensional reduction analysis. To explore this, factor analysis as a multivariate technique is valuable for reducing and detecting relationships among the variables. These are applied to continuous variables satisfying the assumption of normal distribution. The aim is to isolate factors (groups of variables) which underpin farmers' digitalisation of poultry enterprises. Orthogonal varimax rotation was employed to simplify the factor loadings by minimizing cross-loadings of items on the factors (Dilbeck, 2017). Kaiser's criterion of accepting Eigen values greater than the benchmark of 1 for retaining digitalisation factors in the analysis was used. The outputs of isolated factors were named for reporting based on joint interpretation of strongly loaded variables on each factor and guidance provided in the literature (Olanrewaju & Farinde, 2014).

Several categorical variables are equally suggestive of the enterprise's characteristic operations related to the potential for digitalisation. Affirming their relationship with poultry management technicality is deemed as a measure of influence on the potential digitalisation of the enterprise. Factorial

ANOVA is applicable for predicting such change in an interval-dependent variable by the effects of categorical independent characters and possible interactions among them (Paskewitz, 2017). The dependent variable in this regard is the technicality of poultry enterprise management. The independent variables are types of litter management systems, forms of participation in farmers' associations and mode of employment (full-time or part-time) of skilled staff.

RESULTS AND DISCUSSION

Farmers' perception of the relevance of digitalised systems for poultry enterprises

The relevance of digital technologies to poultry management as perceived by poultry farmers is presented in Table 1. It shows that many of the farmers had a positive perception about statements that installation of image-based automatic inspection conveniently monitors bird growth, feeding and watering (69.3%); the combination of electronic information with farm records guides decision making (71.1%), sensors accurately measure environmental conditions for forecasting and management (72.1%), sensors monitor birds' behaviour to ward off predators (66.9%) and drones inspection of large poultry flock is more effective (62.5%). These reflect substantial affirmation by farmers of the potential of electronic data gathering and processing through digitalised poultry production. This reflects a slight variation of the Nigerian Livestock industry from that of the Swiss. Groher *et al. (*2020) reported that Swiss livestock farmers were more familiar with sensors and measuring devices than with data processing digital technologies.

On the other hand, the majority was undecided about using robots to reduce human labour (66.2%), robots' efficient performance of time-consuming and repetitive tasks (59.6%), artificial intelligence expert conversion of data to useful information (64%), 3D printers for repairing and adapting machines for fostering poultry enterprise self-sufficiency (66.9%), the accuracy of artificial intelligence for visual data processing to needed information (65.9%) and that blockchain management of supply chain is incorruptible (66.2%) among others. These responses indicate that a very high proportion of the farmers could not affirm the potential of deploying robots for the effective performance of laborious and repetitive tasks such as setting feeders and drinkers, litter packing etc. In the same way, they could not identify the use of 3D printers valuable for the fabrication and repair of common tools or machine parts. As such, the farmers were unfamiliar with the possibility of utilizing 3D technologies to limit their enterprise reliance on external services and products for managing poultry equipment and thus promote enterprise self-sufficiency. The increasing popularity of artificial intelligence for data processing and informed decisions-making, particularly in enterprise management, is noted to remain largely unfamiliar to many farmers. This denotes a lack of unsophistication in poultry enterprise features and the possibilities for deploying various digital technologies for optimisation. This connotes a dire need for pragmatic promotion and infrastructural support provision for small-scale poultry farming. This could be a measure for inclusive industrialisation as emphasised by the SDG goal- innovation, industry and infrastructure.

Overall, the results depicted a high level of farmers' indifference to the relevance of digitalisation for transforming poultry management activities. This suggests that many farmers still lack a clear understanding of the potential benefits of digital optimisation in poultry production activities. However, a particular proportions of farmers were able to exert a positive disposition towards technologies. This might spur them, if facilitated with adequate promotion and infrastructure, to incorporate the technologies in their enterprise.

Table 1. Perception of the relevance of digital technologies to poultry management

| Perceptional statements	Positive	Undecided	Negative
Installing image-based automatic inspection in poultry farms could help monitor bird growth, feeding and watering efficiently	69.3	18.2	11.7
Electronic information from computer devices or sensors could be combined with farm records for decision-making.	71.1	17	11.9
Information on farm conditions like humidity etc collected with sensors would provide an accurate guide for farmers forecasting and remedies for diseases, drought	72.1	15.4	12.4
Virtual reality allows the farmer to check in on the poultry flock remotely	29.4	66.9	3.7
Sensors effectively help to warn away predators by sensing birds' behaviour with signals	66.9	22.8	10.3
Inspection of large poultry flocks would be more effectively done by drones than by human	62.5	26.5	11
Blockchain electronic ledger for tracking poultry farm produce along the supply chain is incorruptible	19.2	66.2	10.3
AI particularly interpret information collected poultry data far better than humans and can be used to filter the data	69.1	15.4	15.4
AI enables the use of computers to process visual data of poultry farm collected such as with phones to produce information like growth irregularities	29.6	65.9	4.4
Using 3D printers for repairing and adapting farm machines increases farmers' self-sufficiency and avoids potential losses in production	29.4	66.9	3.7
AI could offer expert conversion of data from sensors to useful information	27.2	64	8.9
Robots could be employed to reduce labour costs, particularly for time-consuming repetitive poultry tasks	28.7	59.6	11.8
The use of robots portends opportunities to limit farm labour requirement	19.2	66.2	10.3

Source: Field survey, 2022
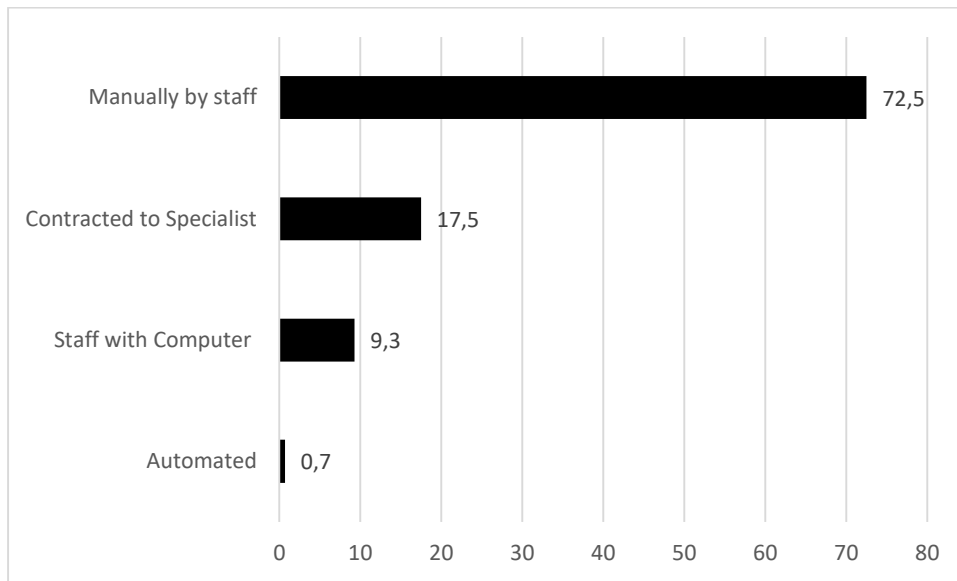
Figure 1. Levels of operation technicality of the poultry farms
Source: Field Survey, 2022

As such, the potential for digitalizing Nigeria's poultry system is hindered by unclear perceptions regarding its relevance and benefits, with only a small proportions of farmers showing a favorable disposition towards it. The evidence indicated that about 1 of 10 farmers with a certain negative view of these technologies' relevance points out the existence of retrogressive forces for their promotion for widespread use and transformation of the poultry sector in Nigeria. Considering this and the findings of Edeoghon & Esene (2018) about social media awareness and limited use in poultry farming leads to the conviction that Nigeria is still far behind in technological upgrades and experience of trending optimisation options as that offered by digital technologies.

The technicality of poultry farm operation
    The results in Figure 1 show that the majority (72.5%) of farmers relied on manual labour for poultry enterprise operations. Only 9.3% used computers for some management activities. Less than one-fifth (17.5%) of farmers utilized specialist services for technical activities, while only a negligible proportion (0.7%) adopted automated management of the poultry enterprise. This illustrates that the majority of poultry enterprises rely on manual operations with low use of computers and ICT tools. The low use of ICTs signals limits technological dynamics of Nigerian poultry industry. Given the importance of the poultry industry in the GDP, the implementation of technological upgrade strategies of SDG goals on industry, innovation and infrastructure could be directed towards enabling digitalized poultry farming promotion and capacity development. This is critical not only for addressing food security and creating jobs in Nigeria but also across Africa (World Economic Forum, 2023).

Constraints to the digitalisation of poultry farms
    Results in Table 2 show that farmers are convinced that digital technologies are only relevant to industrial farms. The view about the indispensable nature of human labour to poultry enterprise is the most vital constraint to the digitalisation of their poultry enterprises. These indicate that most farmers had built the wrong notion that digital technologies could only be used on large-scale farms. They deemed digitalization as irrelevant or inappropriate for small-scale poultry enterprises.

Table 2. Constraints to poultry management digitalisation (n=137)

Constraints to digitalization	WMS	SD	Rank
The technologies are only relevant in industrial poultry farms	3.78	1.49	1st
Humans are indispensable to poultry management	3.73	1.19	2nd
Poor telecommunication network	3.63	1.61	3rd
Digital technology will not be cost-effective in the short term	3.42	1.39	4th
Restructuring the farm would be required and might be costly	3.25	1.34	5th
High cost of procurement to incorporate digital technologies	2.78	1.61	6th
No requisite knowledge of using digital technology	2.22	1.29	7th
The high rate of unemployment might be aggravated by the use of the technologies	2.18	1.45	8th
Cost of internet connection	2.08	1.17	9th

Source: Field Survey 2022

Goher *et al.* (2020) exposed farmers' views of the appropriateness of digital technologies to large and industrial farms due to fear of high cost and complexity of use. In the same way, farmers' agelong reliance on human labour has entrenched the view that digital technologies cannot adequately service poultry operations. The farmers were mostly unfamiliar with technologies for digitalising poultry farming and their potential.

More so, poor telecommunication networks, the fear that digitalisation will not be cost-effective in the short term and the expectation of a high cost of restructuring the farm for digitalisation were indicated as major obstacles to the digitalisation of poultry enterprise. These reveal poor infrastructure as a major constraint to consider implementation of digitalised operation in the farms. These are valid obstacles in the context of Nigeria, given the low level of infrastructural development, particularly in local areas where agricultural livelihoods are prevalent.

Other identified constraints include a high cost of procurement, lack of awareness about technology utilization, potential contribution to the high unemployment rate in the country and high cost of internet facilities. All these focus on low preparedness and technological affinity for a transformed poultry industry. These expose pertinent issues of concern for Nigeria in addressing SDG goal 9 of promoting industrialization, innovation and infrastructure for comprehensive growth and development of the agriculture-based economy.

Factors underpinning poultry enterprise digitalisation

Results presented in Table 3 show the output of the principal component analysis of the factors isolated from variables correlated with poultry enterprise operation technicality. Four factors were retained using Kaiser's criterion (retaining factors with Eigen values 1.0 and above) in the output of orthogonal varimax rotation of 12 associated variables. These were named for discussion based on joint interpretation or explanation of highly loaded variables on each factor with the guidance of established names in the literature (Olanrewaju & Farinde, 2014). Analysis identified four factors namely 'enterprise operational capacity' (λ=4.223), 'digitalisation familiarity and experience' (λ=2.698), 'social contact' (λ=1.375) and management disposition (λ=1.094). These jointly accounted for explaining 78.3% of the variations in the farmers' level of digitalisation of their poultry enterprises.

The first factor, enterprise operational capacity, was named based on highly loaded variables that reflect the enterprise's robustness in terms of size and operational features. These indicative variables include the total staff

strength of the enterprise (L=0.9510), years of production (L=0.867) and poultry flock size (L=0.864). The combination of these variables reflects poultry production size and experience in the system with corresponding labour capacity as jointly related and underpinning the possibility of digital technologies' deployment for optimising poultry management activities. In essence, the production capacity of poultry enterprises significantly underpins the deployment of digital technologies in the sector. This is not far-fetched since such operational capacity indicators influence the enterprise buoyancy, efficiency and productivity. This reflects that the drive towards poultry digitalisation could be premised on the characteristic operational capacities of the poultry farms. More so, this factor is indicated as the most significant of the factors as it accounts for more than one-third (35.1%) of the deployment of digital technologies for poultry activities. This further reflects that poultry enterprise operational capacity represents a cornerstone in the drive for farmers' deployment of digital technologies for production activities. The importance of affordability of the initial investment for digitalisation is identified in the literature as important for enterprise buoyancy and reflects the operational capacity of the poultry enterprise (Shang *et al,* 2021).

The second factor is familiarity and experience of digitalisation (λ=2.698). This is earmarked by the farmer's knowledge of digital technologies (L=0.83), the technicality of poultry management practices (0.785) and the digitalisation constraints faced (L=-0.636). The level of awareness and consequent knowledge about the potential of digitalised poultry farming alongside the severity of constraints facing farmers' deployment of the technologies explain the depth of farmers' familiarity with the technologies. Considering this, the level of technological incorporation in poultry farming such as the use of ICTs; directs to the implication of poultry farmers' familiarity and experience as a veritable precursor of poultry digitalisation. In other words, poultry farmers' familiarity with digital technologies and technical skills substantially influences their drive towards digital technologies. This highlights the imperative of farmers' cognitive experience of digital technologies in a bid for their incorporation into the poultry system. This factor explains 22.5% of digitalisation variations in poultry enterprises. By implication, farmers' acquaintance with digital technologies and their technical experience is critical in understanding and promoting digital technology incorporation in poultry farming.

Relatedly, social contact was affirmed as a factor (λ=1.375) following the high loading of farmers' participation in social organization (L=0.918) and the number of administrative staff of the enterprise (L=0.448). The degree to which farmers participate in social organization highlights their social orientation or cosmopoliteness which functions greatly in keeping farmers abreast of new developments relevant to their production system (Ramirez, 2013). Also, the number of administrative staff employed could indicate the farm enterprise's corporate status and consequent formalized avenues for social contact. In essence, the level of the social relationship between the enterprise and the farmer underpins considerable influence on poultry enterprise digitalisation. This accounts for 11.5% explaining the variations in poultry farm deployment of digital technologies.

The management disposition factor (λ=1.094) was named from the high loadings of farmers' perception of the relevance of digital technologies to poultry farming (L=0.662) and the perceived constraints to digitalisation (L=0.521). As such the disposition of the farmers about the optimizing potentials and applicability of digital technologies alongside their outlook of impending constraints have overbearing implications on the farmers' use of the technologies for their poultry management activities.

Table 3. Factors underpinning potential poultry enterprise digitalisation

Factor Variables	Enterprise operational capacity	Digitalisation Familiarity and experience	Social contact	Management disposition	Variables Uniqueness
Number of birds	**0.864**	0.016	-0.041	-0.041	0.249
Years of production	**0.867**	0.084	-0.184	-0.236	0.153
Admin staff number	**0.620**	-0.144	**0.449**	0.289	0.309
Skilled staffs	0.310	**-0.595**	-0.261	0.386	0.333
Ordinary labour	0.575	**0.566**	0.153	0.048	0.323
Perception	0.034	**0.464**	-0.390	**0.662**	0.193
Total staff strength	**0.951**	0.192	0.034	-0.045	0.055
Social participation	-0.113	0.105	**0.918**	0.054	0.130
Knowledge	-0.236	**0.830**	0.076	0.280	0.172
Practices	-0.226	**0.785**	-0.012	0.087	0.325
Digitalisation constraints	0.154	**-0.636**	0.208	**0.521**	0.257
Eigen values	**4.223**	**2.698**	**1.375**	**1.094**	
Proportion explained	**0.351**	**0.225**	**0.115**	**0.091**	**0.783**

Source: Field Survey 2022

Table 4. Results of factorial ANOVA of selected poultry enterprise characteristics and operation technicality of poultry farms

Source	MS	F	Prob>F	df
Model	77.080	10.72	0.000*	9
Litter management forms	128.698	17.91	0.000*	3
Fulltime or part-time skilled staff	0.688	0.10	0.757	1
Participation in farmers association	25.657	3.57	0.032*	2
Litter mgt forms## farmers association	36.160	5.03	0.003*	3
Residual	7.18			93

Legend: *Significant at p≤0.05; R-squared = 0.5093; Root MSE = 2.68087; *Source: Field Survey, 2022*

In other words, the positive or negative outlook of farmers or poultry enterprise managers towards the importance, needs and requirements of poultry digitalisation is a potent factor determining the deployment of digital technologies. People's perception has always represented a significant threshold of action determination concerning technological adoption (Zhengsong *et al.,* 2018).

Relationship of selected enterprise-related characteristics with operation technicality

The results in Table 4 show the output of factorial ANOVA of some enterprise-related variables and the technicality of operation. It was found that the types of employed litter management systems (F=10.72) and farmers' participation in the poultry farmers association (F=17.91) significantly affect technological incorporation into poultry farms. This illustrates that farmers' use of either deep litter or battery cage systems espouses observable affinity towards the digital automation of the poultry enterprise. This stipulates that the intensive poultry management system especially the battery cage production system could herald some level of preparedness towards digitalised poultry farming. Furthermore, participation in farmers' associations represents a substantial channel for farmers' access to trending

technologies relevant to the poultry business. This substantiates an earlier finding of the significance of social contact as a precursor of poultry enterprise digitalisation. Furthermore, the interaction of the litter management system used and farmers' level of participation in their association is indicated as significantly influencing the operational technicality of the enterprise. The overall model is also significant and indicated for explaining 50.9% of the variations in the technicality of enterprise operation.

CONCLUSIONS

Poultry farmers in Nigeria do not have a clear view of the options, relevance and optimizing capacities of digital technologies for transforming poultry enterprise activities. This indicates the maintenance of the agelong dependence on manual operation. This is amidst the increasing popularity of trending digitalised data processing for enterprise decision processes and activities optimisation. The ensuing relative technological lag is motivated by farmers' conviction that digitalisation applies to large-scale and industrial production levels as premised by supposed high cost, fear of complexity and poor knowledge of the potentials and requirements. Thus, poultry digitalisation is underpinned mainly by four factors, namely the enterprise's operational capacity, digitalisation familiarity and experience, social contact and management disposition. In conclusion, optimizing poultry enterprises through a wide embrace of digitalisation is a distant possibility in Nigeria as underscored by the predominantly poor level of socio-economic buoyancy and orientation of the farmers. The study recommends adaptive research to generate socio-economic class-appropriate digital tools for poultry management. Digital start-ups should prioritize the sensitization of farmers and defuse the wrong notions about digital technologies. This will foster a right appreciation of the potential for poultry enterprise-optimised transformation.

REFERENCES

Akinwale, J., Wole-Alo, F., & Oluwole, B. (2023). Digital Platforms for Linking Agriculture Investors with Smallholder Farmers in Nigeria. *Journal of Agricultural Extension*. https://doi.org/10.4314/jae.v27i2.6 .

Degila, J., Sodedji, F., Avakoudjo, H., Tahi, S., Houetohossou, S., Honfoga, A., Tognisse, I., & Assogbadjo, A. (2023). Digital Agriculture Policies and Strategies for Innovations in the Agri-Food Systems – Cases of Five West African Countries. *Sustainability*. https://doi.org/10.3390/su15129192 .

Dilbeck, K. (Ed.) (2017). Factor analysis: Varimax rotation. In *Allen M. (ed) The SAGE Encyclopedia of Communication Research Methods (Vols. 1-4).* SAGE Publications, Inc, https://methods.sagepub.com/reference/the-sage-encyclopedia-of-communication-research-methods

Economic Commission for Latin America and the Caribbean (ECLAC) (2021). *Digital technologies for a new future* (LC/TS.2021/43), Santiago.

Edeoghon, O., & Esene, F. E. (2018). Awareness and use of social media among urban poultry farmers in Ikorodu lga, Lagos State, Nigeria. *East African Scholars Journal of Economics, Business and Management,* 1(1), 21-26.

Food and Agriculture Organization (FAO) and International Telecommunication Union (ITU) (2022). Status of digital agriculture in 47 sub-Saharan African countries. *Food and Agriculture Organization*, Rome, Italy. https://doi.org/10.4060/cb7943en

Gorenšek, T., & Kohonta (2019). Conceptualization of digitalisation: opportunities and challenges for organizations in the euro-Mediterranean

area, *IJEMS,* 12(2), 93-115. http://www.dlib.si

Groher, T., Heitkämper K., & Umstätter C. (2020). Digital technology adoption in livestock production with a special focus on ruminant farming. *Animal,* 14, 11, 2404–2413. https://doi.org/10.1017/S1751731120001391

Heise, H., Crisan A., & Theuvsenc L. (2015). The Poultry market in Nigeria: market structures and potential for investment in the market. *International Food and Agribusiness Management Review*, 18, Special Issue A: 197-222.

LiveGAPS factsheet (2020). *Poultry production in Nigeria*. CSIRO, https://research.csiro.au/livegaps/wp-content/uploads/sites/37/2021/03/1.-LiveGAPS-factsheet-Poultry-production-in-Nigeria-22-April-2020.pdf

Netherlands Enterprise Agency (2020). *Poultry sector study Nigeria*. Netherlands Enterprise Agency, Prinses Beatrixlaan, The Hague.

Olanrewaju, K. O., & Farinde, A. J. (2014). Factors Influencing Use of Traditional Communication Methods in Information Dissemination Among Farmers in Osun State, Nigeria, *Journal of Agricultural and Food Information,* 15(1), 54-68. https://doi.org/10.1080/10496505.2014.866005

Oruma, S., Misra, S., & Fernández-Sanz, L. (2021). Agriculture 4.0: An Implementation Framework for Food Security Attainment in Nigeria's Post-Covid-19 Era. *IEEE Access*, 9, 83592-83627. https://doi.org/10.1109/ACCESS.2021.3086453

Paskewitz, E. A. (2017). Factorial Analysis of Variance. In Allen M. (ed) *The SAGE Encyclopedia of Communication Research Methods* (Vols. 1-4). SAGE Publications, Inc,

https://dx.doi.org/10.4135/9781483381411

Ramirez, A. (2013). The Influence of Social Networks on Agricultural Technology Adoption. *Procedia - Social and Behavioral Sciences.* 79. 101–116. https://doi.org/10.1016/j.sbspro.2013.05.059

Shang, L., Heckelei, T., Gerullis, M., Börner, J., & Rasch, S. (2021). Adoption and diffusion of digital farming technologies - integrating farm-level evidence and system interaction. *Agricultural Systems*, 190. https://doi.org/10.1016/j.agsy.2021.103074

Umar, M., Sani, B., & Suleiman, U. (2022). An Overview of Machine and Deep Learning Technologies Application in Agriculture: Opportunities and Challenges in Nigeria. *SLU Journal of Science and Technology*. https://doi.org/10.56471/slujst.v4i.273

World Economic Forum (2023). *5 ways to strengthen Nigeria's poultry supply chain*. Retrieved from https://www.weforum.org/agenda/2023/09/5-ways-to-strengthen-nigerias-poultry-supply-chain/

Zhengsong Y., Xiaojian L., Erling L., Yeqing C., & Junhui M. (2018). Influences of Value Perception on Farmers' Technology Adoption Tendency and Conditional Response-Based on the Micro Data of 338 Farmers. *NeuroQuantology.* 16. 494-500. https://doi.org/10.14704/nq.2018.16.6.1670